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ABSTRACT

The current curricular structure in engineering education does not allow for developing students' creativity, flexibility, capacity to work in a group, or ability to initiate work opportunities. This paper explores the concepts of "field of professional performance" and "knowledge area" as they relate to modern engineering education and preparing students to meet these goals. (WRM)

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Field of Performance and Area of Knowledge: A Structure of Reference in Engineering Education

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Abstract - *Since the societies started to be organized, they felt the necessity to have inside its structure, well prepared people to intervence in the problems that appeared, in the most several fields of performance. These well prepared groups of people were so important that same societies itself started to provide conditions to give them an special formation. In some cases, the societies itself struggled the whole expenses outlaied on this formation. At a very simple way, that would be one explanation for the appearance of the courses of professional formation, of the universities and, besides, one of the reasons for the creation of the public universities. In order to be more organized, the whole variety of problems that emerged on the societies were divided in groups which should have a similarity on its intervention object. From these groups emerged the various professional fields ant the various professions. Field of professional performance is conceived as being the way to act in the problems of the population already applying knowledge existent and available, for different areas and types. The professional's field performance is characterized, also, for being established for legislation and for looking for subsidies in several knowledge areas. That is, therefore, the second division that was necessary, also for a better labor organization: the production and knowledge systematization was also segmented in areas through one or more objects, that we named study objects. Knowledge area is conceived, therefore, as the way people oct over a study object in order to produce and reorganize the various types of knowledge existent in relation to him. These consideration, joined to the fact that the professional formed by universities can not assure that he is going to have an sctructured and warrented job, seems to indicate that the professional fields are assuming new characteristics. And for them to be constantly assuming new characteristics they need to be examined considering the knowledge areas that subsidize them. Those changes consequently claim graduated people to have a differentiated perfil, able to adapt to the presented exigences, to solve the comminity problems, but also able to criate your own space of professional performance. All this seems to indicate that is necessary to create a new knowledge area which has as a study object the inter relation betweem the professional fiel and the varios knowledge areas that subsidize them. In this context, the purpose of this paper is to explore the concepts of field of professional performance and knowledge area, and also to propose a form where they can be used as a reference structure for the discussion of the strategic subjects linked to the teaching and the formation in engineering.*

Definitions

Since the societies were organized, it was needed to have inside of its established structure, people prepared to intervene in any problem that appeared, in every field of performance. That group of people prepared to solve problems acquired such importance that those societies created conditions to give them a special formation, and in some cases, opted even to pay the current expenses of that formation. In the possible simplest way, this would be one of the explanations for the birth of the universities and, besides, one of the reasons for the creation of the public universities.

In order to have the labor organized, the multiple social problems were divided in groups, most of them according to the intervention object of each one, and it resulted in the different fields of profession.

According to Rebelatto & Botomé [4], the field of professional performance is defined as being the way to act, characterized by the direct intervention in the problems of the population, with the objective of assisting them at the most effective way, through the consumption or application of the knowledge already existent and available for different areas and types. The field of professional performance is characterized also for being established by the official legislation and for looking for subsidies in several knowledge areas (to see Fig.1). Therefore, the second division that was necessary for an organization, also with the purpose of organizing the different fields of for the labor was the following: the production and sistematization of the knowledge. They were segmented in areas, in function again of one or more objects, called study objects. Knowledge area is defined, according to the same authors, as the way to perform around a study object with the objective to produce and to organize the different existent types of knowledge related to him. Unlike the field of professional performance, that is regulated and it possesses defined inclusion, the knowledge area does not possess formal limits, fact that allows the rise of one of the largest wealth in the

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production of the knowledge that is the exploration of the interface among the several areas.

Considering those assertives and distinctions, it is possible to establish some existent relationships between field of professional performance and knowledge area. Starting from the conception, we have that field of professional performance comes from the direct intervention related to the population's problems , throught the application of the existent and available knowledge in the different knowledge areas. That means, then, that in the knowledge areas the knowledge is produced. And the population can acess it through several forms; perhaps the most important is the professional formation. The teaching (specifically the graduation teaching), is responsible for the connection between the knowledge produced and organized and the formed professional. So, teaching at the graduation level, through the curriculum of the different courses is an important definitor of the field of performance for each professional formed by the universities.

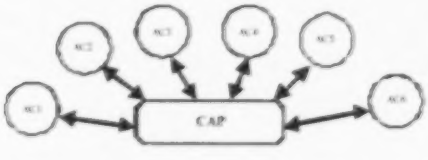

Figure 1. Shows a Scheme Representing a Field of Professional Performance (CAP), the Knowledge Areas (AC) that Subsidize him and the Necessary Interdependence Between them.

Teaching and Research

It seems important, in this point, to open a parenthesis to the discussion of a subject that has been headline in the communication vehicles nowadays. It is about the dislinkage of the research and the graduation teaching that is happening a lot in the brazilian higher education.. That dislinkage suggests that the research should be made in excellence centers and the teaching process should take place in the universities. That is already an existent practice in some countries, but that needs some special care to be effective. Up to now, the definitions of knowledge area and field of professional performance indicates that the universities should count on a teacher that is also a researcher, or a researcher that also exercises the teaching function. In that way, the linkage between produced and organized knowledge and professional performance would be being made by the teaching process, that is, through the curriculum that choose the disciplines that should be teached, with the objective of forming the professional that the society needs to solve its problems.

This discussion can be extended if we think about the role played by the university teacher. According to Botomé [1], an university professional–called university teacher–he/she needs to be a multiple professional. He needs to be a technician and also a specialist in his field of performance (Economy, Psychotherapy, Civil Engineering, Medicine, Pedagogy, etc). But he also needs to be competent to be a researcher or cientist in an area of the knowledge. There are already two professions, but it does not end here. The exigences are still larger. He also needs to be a teacher of superior level capable to teach and to prepare professionals to accomplish the most demanding and complex tasks of the society. And, besides, he still needs to be capable to be an administrator. He will be put in confront with situations that will depend on its capacity to manage research projects and its capacity of teaching, to coordinate work groups and many other university activities.

When we distinguish knowledge area and field of professional performance and explicit its interdependence we can clearly see the intimate and necessary linkage between the processes of knowledge production (research) and the teaching-learning process. In the same way, it is possible to argue about the abilities and the performance of the one who is responsible for both processes: the university teacher.

In the case of having a system where researcher's and teacher's functions are disentailed, who will be the one responsible to establish a connection between existent knowledge and professional performance? Certainly it will be necessary to think about a system that foresees this question and develops a mechanism that guarantees this relationship.

Globalization, Teaching and Work

Returning to the examination of the field of professional performance, what can be observed is that it is a dynamic concept, in spite of the characteristic "established for legislation." The societies develop and its needs modifies, mainly in function of the new technologies that are developed. A good example for those alterations of needs in function of new technologies can be observed, nowadays , with the progress of the computer science. The speed of transmission of information not only brought other characteristics for the existent societies as it destroyed borders in several aspects, bringing the process that we call globalization.

The globalization is seen, then, as an expansion of the paper of the market in the coordination of the world economy, provoking damages on the regulatory capacity of the State and also creating the panic of the growing and permanent unemployment. People have been talking a lot about the fear of the "technological unemployment", but when analyzed as the historical point of view , such aspect can be understood as an old and appealing fear.

According to Campos [3], in the XIX century , machines were broken in England while the industrial revolution was exploding . The expression "sabotage" comes from the wood soled shoes called "sabots" that were thrown into the weaver's loom to

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damage them. There was great social commotion in Paris when the siblings Perrier installed two bombs in Chaillot, in 1782, the ones which, pulling the waters of Sena for heights of 35 meters, suddenly turned unemployed 22 thousand loaders of water. The automobile provoked the disappearance of the industry of carriages and it depopulated the stables, and the electricity liquidated the industries of candles and lamps.

Today, the computer and the robots are seen as great menaces to the employment. But what we have seen is that the technological progress has some auto-corrective virtues It is right that it can generate temporary and sectorial unemployment, but the increase of the productivity, elevating the income and lowering the prices, induces the increase of the demand in varied directions. Thus, the industrial unemployment can be compensated by the expansion of services in finances, communications, tourism, health, and entertainment , as well as by the increase of the solemnity-employment in individual enterprises.

What seems to be clear is that in a market of fast mutation, as the one that we are facing now , the borders among the professions become more and more fine and the professionals formed by the universities no longer can count with a structured and guaranteed employment waiting for them as soon as they graduate.

Those considerations seem to indicate that the fields of professional performance are assuming new characteristics, besides they are presenting new positions, what also determines new superpositions among professions (see Fig.2). Those changes demand , consequently, that the graduated professionals have new characteristics, that they adapt to the new presented demands, so they cannot only assist the community's needs where they act, but will have condition to create its own space of professional performance, inside of that community.

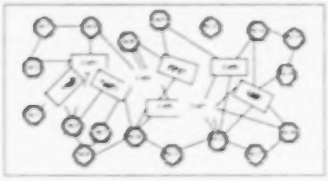

Figure 2. A Schematic Representation of the Several Possibilities of Dependence Relationships Among Knowledge Areas (AC) and Fields of Professional Performance (CAP).

All these makes us believe that it is being necessary to create a new knowledge area, whose study object is exactly the interrelation among the fields of professional performance and the several knowledge areas that subsidize them. In another words, it seems emergencial to create a constant monitoration of the social way in order to continually modernize the community's needs. Those modernizations can create or destroy the dependence lines between the knowledge areas and the fields of professional performance, in a perennial way. Starting from the data about the enviromment monitoration, what is in another words the constant rising of the community's needs for each one of the professions, it would be possible to manage the modernization of the field of professional performance and, in a second moment, we would have conditions to trace new guidelines for the several professional's formation and, still , it would be possible to do a planning on how to modernize the already existent ones, in the labor market.

From the Needs of the Society to the Teaching Process - The Case of the Production Engineering

Botomé et al. [2], proposed an outline of reasoning stages and also of the behavior of the ones who plans the teaching, altering substantially the previous sequence. The starting point is what the community needs, passing to the decision point where it is defined what the professional should be capable to do to assist the community's needs, what is necessary to teach for the student to be capable to act in that direction and which are the existent information and which is the one that needs to be produced and added to the professional formation in order to make him capable to assist the longings enviromment where he will be acting. The starting point of the analyses and decisions of an educational system is not what " is in the books", but a "knowledge of the reality." The "existent information" only appears as an instrument in the levels of decision.

In that context, the excel matter of teaching stops being the information or the knowledge as a product, and it becomes to be understood as being constituted by the behaviors–the types of relationships with the reality–that import to develop and generate the society that interests. From then on, emerges the input that needs to be processed to generate the definition of the behavior of interest:

1. the concrete situations of the students' performance,
2. what interests for the society, as a result of its performance and
3. what types of actions would build those transformations.

Starting from the knowledge on the aspects of the reality here referred, it will be possible to set the definition of the field of the professional's performance and, in subsequent action, the establishment of the connections among that field of professional performance and the knowledge areas that should subsidize him.

The production engineering can be used as an example. It was regulated through the 860/77

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semblance , on March 10, 1977, characterized as Methods of Engineering and, due to the predominant technological determinism of the current time, it received a identical structured curricular to the other areas of habilitation of the existent Engineering, which are: Civil, Electricity, Mechanics, Metalurgia, Mines and Chemistry. On May 16, 1977, through the Resolution 10/77 it was characterized according to the following main points:

- The Production Engineering is a specific habilitation that can have its origin in any area of the Course of Engineering.
- This habilitation should occur in the terms of the Resolution 48/76, dated on 27.04.76, by the Federal Council of Education, that fastens the minimum of content and duration of the Course of Engineering, and defines its areas and habilitations.
- The matter of general administration formation, related in the article 4. of the Resolution 48/76, should be unfolded in way to cover Accounting of Costs and Organization of Systems of Production involving Human Activity.
- The discipline of general formation in economy, related in a paragraph of the article 4. of the Resolution 48/76, should be unfolded to cover Industrial Economy (Theory of the Production, Costs and Offers) and to give emphasis to the Economic Engineering.
- In the cast of the specific disciplines of the professional formation, referred in the article 8., of the Resolution 48/76, the following ones should be included:
    - Quality Control.
    - Methods of Operational Research
    - Study of Times and Methods
    - Production Planning and Control.
    - Project of Product and of the Factory.

The Production Engineering was born facing the ground-of-factory operations, but it extended to the other sections quickly. Today, besides the specific knowledge that are applicable to the productive sections, it is necessary to develope others, applicable faintly to any area of the enterprise. A company is a system, and as such it should be understood. Its activities and problems are interrelated, and they should not be negotiated independently. The knowledge in finances, finance markets and human relationship in the work are applied either to the productive section as well as to the administrative section.

Therefore, we can suppose that the production engineer's professional performance can contribute to the modification of the existent economic reality in a country. When doing that punctuation, we intend to stand out the intrinsic connection between the production engineer's professional actions and the atmosphere where he acts, mainly in the economic and financial aspects.

The promotion of a differentiated action of the production engineer in that context depends, largely on the existent knowledge, on the abilities acquired in elapsing its professional formation, and in synthesis, on the learning conditions that are offered in the ambit of the graduation course.

The educational technology has been making significant progresses in the discussion to form the professional from future to assist the needs of the society where he will act.

About this subject , Botomé et al. [2] highlighted that, to have the teaching process attached to an effective performance of the professional in the situations where he will live, it is necessary to think about the following:

1. What is needed to be produced as a result of the actions of the current students, when they get graduated?
2. With what aspects of the reality the students will have to work, when graduated, to produce those results?
3. What should the student be capable to do to work with those aspects of the reality (existent in the situations wich they have to confront) in a way to produce a significant result for his own life and for other people 's lives?

When it is examined what it is done in the practice, even so, the usual starting point to drift and to accomplish the teaching is different. In general, the starting point is the existent "content" from where it is chosen what should be taught and how that content will be transmitted to the professional in formation.

The conception of field of the production engineer's professional performance and the analysis of the interdependences with the knowledge areas that give him subsidy cannot drive the decisions that move the starting point to drift and to accomplish of the teaching of the "content" existent and well-known, for the real social needs of that professional's performance.

Final Considerations

The non explicit consideration of the market demands and of the new fields of performance that are going to be created due to the evolution of the world ends up constituting an obstacles to the engineer's formation, that is restricted and regulated by old and very rigid Resolutions which t were surely developed to a scenery very different from the current.

The curricular structure shows this problem. . It does not privilege the creativity, the flexibility, the capacity to work in groups , the initiative of recognizing and creating work opportunities in the engineer's formation .

Technical competence in a certain area is only part of an academic formation. The involvement with economic, social subjects and its interactions are responsible for a good portion of the success in the formation and the engineer's survival.

The model of current teaching, seems to be favoring the placement of a non contextualized engineer in the market, because it valorizes the

technical subjects and sees the teacher as the source of the knowledge.

The definition of the engineer's profile for the year 2000 has been worrying the researchers and the universities. However, it seems that , the concern still didn't find the technical back-up and there is a lack of structure reference about what should be taught in the engineering education..

The investigation about what the market is going to demand, due to its temporality, doesn't serve as a reference source for the curricular changes , neither does the academic experiences of the different universities when taken separately.

Thus, it seems that the concept of field of the engineer's professional performance supplies a structure of appropriate reference to identify the real situations that the formed professional will confront and the necessary behaviors to work in an effective way with those situations.

Besides, the analysis of the interdependence between the field of engineer's professional performance and the knowledge areas that subsidize them cannot give the directions to the decisions on curriculars alterations and to the optional disciplines that will be offered and they can not even be the base for the elaboration of modernization programs for professionals already formed.. In that way, the determination of what should be taught will be done with the explicit consideration of the paper that the engineer will carry out and of the expectations that the society will have on him. This could come to be the answer for the subjects generated by the professional's obsoletism that the university has been forming.

This position can, still, to valorize the competences acquired by the higher education Institutions and its teachers.

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